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Federal Communications Commission
Washington, D.C. 20554

Re: ET Docket No. 03-104, Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems

To the Commission:

I am responding to your Notice of Inquiry on the referenced Docket with what I feel is a somewhat unique set of perspectives: I have been a licensed Amateur Radio Operator for more than 40 years, holding the Advanced Class call of WA9ENA; I presently live in a rural area which I believe to be qualified as "under-served" by broadband services (no CATV service available, too far from a telephone central office for DSL services, and the available analog telephone system is only able to support maximum modem speeds of 28.8 kbps); finally, I am a professional EMC Engineer ("Electromagnetic Compatibility"), carrying certification by N.A.R.T.E., having been employed as a professional in that capacity for 17 years. In my more than 35 years of employment, I have worked in telecommunications, radio frequency shielding systems, and aerospace navigation and communication systems. I am a member of the IEEE and its Standards Association, serving as Chair of a standards working group. I have also worked, under contract, in the changing and drafting of Military Standards relating to EMC design issues for fixed facilities. I served in Ground Radio Maintenance with the US Air Force Reserves and was associated with the USAF MARS program for a number of years.

I appreciate the opportunity afforded to comment on the BPL issue, as I feel strongly that it has the potential to affect very large numbers of Government and licensed users of the HF and VHF spectrum. I ask that monetary considerations of potential commercial revenues be set aside until the full impact of what such a system may cause is fully understood and considered.

Before I begin addressing specific points of the Docket, I would like to go on record as supporting a portion of the BPL proponents' concept: partial re-use of existing resources - namely, the power poles. I definitely do <u>not</u> support the sending of high speed data over open wires. For the Access BPL systems (as defined in Part III, Section 14 of the Docket), the power poles and other right of way infrastructure should, in my opinion, be outfitted with a fiber optic system for the carriage of that data. Use of fiber optics would provide near total elimination of the electromagnetic ("EM") problems with which the wired system is fraught. Because optical fibers are non-electrically conductive, they can not radiate signals into the environment, nor can they be susceptible to EM signals in the environment. I clearly understand that a fiber optic based system is not within the scope

of the proposal at hand, but it is an alternative technology that is available and proven which merits consideration, albeit over the probable objections of most BPL proponents. In fact, I would not be surprised if the low voltage transformer by-pass device, mentioned in Part III, Section 13, might actually employ fiber optic technology as a possible means to pass the high speed data signal around the residential drop transformer.

You ask for technical comment in Part III, Section 15, on a number of bulleted items. I would like to address some of those bullets: (Please bear in mind that most of the issues discussed would be moot if fiber optic technology was used for the Access BPL systems.)

- The systems which have been granted experimental access to the 1.7 to 80 MHz spectrum offer the greatest threat to existing services, both Governmental and licensed, because of the potential for significant unintentional propagation over large distances and coupling into or from antenna systems of the current users of that spectrum. Please note that the lower a system is in frequency, the longer its wavelength and the larger the effective apertures will be of typical resonant antennas used for communications at those frequencies. With the longer wavelengths also comes the increased area of the associated near fields, which impacts the coupling coefficient between antennas and any power lines which may run in close proximity to those antennas. A better choice of frequencies might be the current VHF television broadcast frequencies, which I believe are due to be vacated within the next few years as digital broadcasting on UHF frequencies replaces the current analog systems. Alternatively, a somewhat lesser bandwidth system could be operated in the LF and VLF spectrum, where the power companies already operate carrier current systems for control purposes.

- If the Access and In-house BPL systems are to demonstrate any degree of robust performance (e.g.: rejection of interference), then I see little reason that they should not share the same spectrum. If the Access BPL system were to use fiber optic transmission media, potential interference would be a non-issue.

- One bullet briefly mentions data security. As proposed, this system would appear to be a hacker's dream come true. Very robust encryption schemes will be needed to reduce the chances of data interception and deciphering from a very widely dispersed source (the power lines), as well as to prevent cross-transfer of data among multiple users of a given BPL carrier. Frankly, this appears to me as one of the major flaws in the BPL scheme and it alone should be a cause for re-thinking the entire concept. I would suggest that the Commission invite input from experts in the TEMPEST and anti-hacking communities on this topic.

Part III, Section 18 correctly mentions the multitude of users facing potential interference from these proposed systems in the HF and lower VHF spectrum. It is interesting to note that the proposed spectrum of 1.7 to 80 MHz affords protection to the standard AM and FM broadcast services, but infringes upon all of the other licensed and authorized users

of that portion of the spectrum. In my mind, this is not equal protection! Equality would be that this sort of system never gets deployed within a spectrum containing licensed, incumbent users.

More bulleted questions are raised in Part III, Section 20. My comments on some of these are as follows:

- The high pass filters of the Access BPL filters will allow all signals above the lower cut-off frequency of the filter to pass into/onto the system. This could include common mode coupled RF energy from licensed transmitters within the house which happen to be within the operating bandwidth of the BPL system. The likelihood of this occurring is especially high in high density living areas (such as apartment and condo complexes) where antenna restrictions force many legal, licensed Amateur Radio operators to utilize indoor antennas. These antennas are usually located in either the attic or some portion of the living area because outdoor antennas are not permitted. Such antennas will couple very well onto the building low voltage electrical wiring and have the possibility of passing around the BPL system coupling device by means such as stray capacitance. If any of the common mode coupled energy is converted to differential mode due to system imbalances, the external RF signal will blend in with the system data signal and possibly constitute in-band interference.

- Under no circumstances should an Access BPL system be deployed that uses an unbalanced transmission configuration. The performance of balanced transmission systems is borne out by the very high performance achieved within the public switched telephone network. Despite long runs of cable, often within a few feet of parallel power lines, the level of power line hum reduction afforded by a carefully controlled balanced line installation is self-evident. Anyone who has ever picked up a telephone and gotten a loud blast of 60 Hz hum in their ear knows what happens when the balanced system becomes unbalanced – usually because of a broken wire connection. However, the telephone system also employs twisted pair conductors, which play a critical role in minimizing external field coupling. The power line pairs are not twisted, so the self-canceling field effects enjoyed by the telephone system will not be available to the BPL system. The only serious hope of minimizing interference to present users of the spectrum is for the Commission to insist that all such systems be run as balanced configurations. The same approach that minimizes external field common mode susceptibility also reduces common mode emissions.

- The balanced configuration is achieved when the BPL signal is fed between any two phases of the power system. However, in many rural areas, the local medium voltage distribution is single phase: one wire carrying power (one phase only) and a return. If the return is not grounded at the individual

drop locations, then this could be used as a legitimate balanced system, tied back to the feed point where separation from the 3-phase main line occurs.

- Common mode rejection capabilities of a balanced system are dependent on a number of factors, one of them being constant impedance for the transmission lines. For purposes of the BPL signal, the line impedance will be determined primarily by the spacing between the wires. Whenever the impedance of the transmission line substantially changes, such as when the spacing between wires halves or doubles, and some device is not employed at that point to match the two impedances, there exists the opportunity for conversion between differential mode signals (the BPL data stream) to common mode signal (the unintended radiation of the BPL signal). The reverse action is also possible, in which local common mode signals (RF from legal transmitters, lightning transients, etc.) can be converted into differential signals, thus corrupting the data stream. BPL system developers need to be aware of this effect and allowable emission limits should be set low enough that these system imbalances do not affect either spectrum users. Conversely, system susceptibility levels must be such that external in-band signal incursions do not affect BPL users.

- There is most definitely a need to define frequency bands which need protection from BPL transmissions. These would be all of the Amateur Radio bands in the HF region, plus the 50.0 to 54.0 MHz band. Add to that list all other Amateur Radio bands above 54 MHz if the BPL systems extend beyond 80 MHz. There are a multitude of public safety and industrial users in the 30 to 42 MHz region. All of these services use radio receivers with typical sensitivities well under 0.5 uV, or better than -114 dBm. Multiple natural disasters, such as severe flooding, hurricanes, and tornadoes have resulted in extensive use of two HF bands in particular, the ones from 3.5 to 4.0 MHz and 7.0 to 7.3 MHz, by radio Amateurs in handling regional communications to damaged areas without other means of communication. The Commission has imposed temporary quiet zones around certain frequencies in these bands during severe emergencies to keep the important communication lines open. Since radio operators in the stricken areas often have to operate under adverse conditions with sub-optimal antennas, those operators located elsewhere who are attempting to maintain contact with the stricken areas would be severely hampered if forced to copy radio messages surrounded by periodic (or aperiodic bursts of) data from nearby unintentional emitters. It is critical to the proper and continued functioning of Amateur Radio's role in emergency communications that the allocated frequency bands not be polluted with data transmissions. These bands are already tasked with enough existing emitters, including lightning, electric fence chargers, automotive ignition systems, hair dryers, and numerous other devices which render communications difficult, if not impossible, at various times.

- The only effective means of protection for communications with public safety, law enforcement, and Amateur Radio mobile units traveling under or alongside medium voltage power lines is to have either no emissions in the affected bands or emissions so low that the BPL system will not be able to function[1]. It is very possible for a data system to fully meet all conformity requirements and still present harmful interference to licensed radio communication users. This problem is borne out daily by thousands of VHF and UHF system users who, in the course of using their radios, pass by gasoline stations, banks, and major retail centers while attempting to conduct two-way communications. The digital systems used in point of sale and commercial computing are designed to meet FCC Part 15 Class A requirements, which have higher emission levels than Class B systems. When these systems are clustered, as they usually are in these locations, the cumulative effects are such that many communication channels are lost for use while the mobile is near these systems. In some cases, "near" can be defined (from personal experiences of the author) as a city block, or further.

- These systems, if deployed, should be classified under residential, Class B, environments for all locations, no exceptions. That should apply to both Access and In-house systems. However, it is entirely likely that without definitive notches in the Amateur Radio bands, even Class B emission levels will cause harmful interference because of the sensitivity of modern receivers[2].

- As regards emission limits for Access and In-house BPL systems, I reiterate my comment about nothing less than Class B, knowing that even those levels will cause harmful interference to some communication users. Any suggestion to permit higher emission levels for In-house BPL because "the user would be the principal party affected by the interference" is flawed thinking. It may be correct for isolated residences in rural areas, such as where I live, where each residence is isolated by virtue of the fact that every house has its own separate low voltage power transformer. In city and suburban areas, multiple dwellings share a common transformer secondary. Further, direct power line coupling is not required to cause harmful interference. Radiated emissions can be of sufficient magnitude to couple through building walls and into equipment not owned or used by the BPL user party. I have provided some professional consulting to medical facilities in which standard personal computers (the types operating with Class B certification) were causing interference to sensitive medical equipment which used RF frequencies in the HF region. The computers were in another office, on the opposite side of the wall from where the affected medical equipment was located. The analogy here is that if a

[1]Page 6, White Paper, "Calculated Impact of PLC on Stations Operating in the Amateur Radio Service", Hare, Ed, W1RFI, November 2002, presented at ANSI C63 Meeting, Rockville, MD.
[2] *Ibid.*

licensed Amateur Radio operator was forced to use an indoor antenna because of restrictions against outdoor ones, there is an excellent likelihood that he/she will experience harmful interference from Class B systems owned or operated by others in high density residences.

Part III, Sections 20 through 23, discuss measurement methods and techniques. I will limit my comments to these few: 1) All measurements should be as radiated, and done uniformly, for all Access and In-house BPL systems. 2) Because of the wide variety of possible installation scenarios, the Commission, industry, and representatives of affected spectrum users should work in concert to develop a minimum of three (3) "typical" installation types for each BPL system configuration (Access and In-house). Tests should then be run on these sample systems to obtain quantitative data and the affected users should be permitted to operate samples of their equipment in those test environments to confirm compatibility of the test results with real-world situations.

Although interference to the BPL systems is mentioned in the Docket text, nowhere does the Commission seem inclined to force a degree of RF susceptibility protection onto the proposed BPL systems. It is my opinion that lacking an enforceable degree of RF immunity on BPL systems is tantamount to simply recreating the chaos and contentiousness that has run for decades between Amateur Radio operators and the television watching public. Many computer equipment manufacturers have been making and selling digital equipment designed to comply with the European standards of a minimum of 3 V/m for RF immunity for several years. It is past time for the Commission to be prepared to apply at least that minimal level to these systems, if not to even higher levels. BPL system manufacturers, especially those making Access equipment, will really have no control over deployment of their equipment. Even if a given Access system does not pass by the residence of an active Amateur Radio operator, there is no way to predict when a mobile unit will travel the road alongside the wires and transmit, possibly with several hundred watts of power. The power company will not be a happy system operator if they continue to get reports from irate BPL subscribers about lost data or interrupted transmissions. I contend that there is market pressure to force RF immunity, but the Commission could level the playing field by mandating at least some minimum level of required immunity.

In summary:

- Only existing power poles should be re-used for the Access BPL systems. No broadband data should be sent over the open power wires; instead, fiber optics should be used for the Access portions of the proposed system. Most EM issues would be moot in that event.

- The proposed spectrum allocation for the BPL systems is not affording equal spectrum protection to all licensed HF and low VHF users.

- The potential for data theft and corruption would seem to be very high. Input from experts in these areas should be sought relative to mandated encryption techniques.

- Only balanced transmission line techniques should be permitted for Access systems. All compliance measurements should be radiated, and Class B limits used, nothing higher. It will be necessary to provide notches in the spectrum to avoid harmful interference to most Amateur Radio users, but it is also likely that some (many?) users will experience harmful interference even with notches.

- Licensed Amateur Radio operators in high density residences will be adversely affected by both the Access and In-house systems. The Commission must mandate realistic immunity levels so that fields coupled from indoor or closely located outdoor antennas in these high density situations do not impact either form of BPL system.

- If BPL systems are deployed, there should be some mechanism to disable those operating in certain geographic areas if Amateur Radio operators are assisting with emergency communications. This would be a parallel to the Commission's current practice of ordering temporary quiet zones around specific frequencies during emergencies. Note that this could apply to areas hundreds of miles from the stricken emergency zone when HF communications are being used.

- The separation of BPL into Access and In-house is a good concept. As a rural user, I would have the option to not use the In-house BPL if I feel that it will interfere with my HF communications. I am far enough separated from neighbors who may elect to use In-house BPL that it is not likely their system will affect me, providing those systems meet Class B requirements. Also, I do not share a power transformer with any neighbor. However, even if I chose not to use the BPL system, I will have no say in the pollution of the local EM environment if the Access BPL is running on the medium voltage lines providing my house power. Further, depending upon the HF band I chose to operate and time of day, it is possible that my communications will be affected by radiated fields from distant BPL systems.

- Stringent emission and susceptibility requirements must be established for these systems. Testing and evaluating of system performance must be monitored by representatives of all incumbent services affected by the proposed spectrum. Any deployment permits issued by the Commission must have clauses to protect the existing spectrum users and clearly lay effort and cost of interference correction on the doorstep of the BPL system owners and equipment manufacturers.

- The Access BPL system, operating as a widely dispersed RF source, has the potential to interfere with virtually all HF communications, fixed or mobile. Since it is not likely that a working system can be easily made which does not significantly infringe upon existing spectrum users, the proponents of

this system should be made to see the flaws in their concept and reconsider the advantages of the closed environment offered by fiber optics. The costs may not be as high as expected when they consider the effort required to attempt to meet a non-interfering situation with current users and the extent to which they will have to employ RF immunity measures with the open wire system.

- Events in that past few years have shown the Commission, and the country, what Amateur Radio operators can do in times of emergency. While these actions have been happening many times per year for the many decades of Amateur Radio's existence, the importance of a functional cadre of communicators to assist local law enforcement, and others, has never been greater. (I am both a registered Emergency Responder in my county to the Sheriff Department and a certified Weather Spotter for NOAA.) If the capability to carry forth with routine HF communications in between the emergencies is disrupted by an across the board in-band source such as the proposed BPL system, then it is my opinion that we will not have a sufficient cadre of emergency communications personnel for future situations. It is not in the best interest of the country to lose great numbers of licensed Amateur Radio operators. I respectfully request that this issue be kept in mind by the Commissioners when reviewing the merits of the BPL system.

Again, my personal thanks for the opportunity to comment.

Sincerely,

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NARTE Certification #EMC-001549-NE